Adult and Adolescent Social Behaviour: Experimental Data from the Trust Game

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Abstract

Twenty-four adults (aged 19–35) and 27 adolescents (aged 13–14) played as 'Trustee' in an iterated Trust Game against a pre-programmed set of 'Investor' moves, said to belong to an unknown co-player. Trustee behaviour was examined first in response to normative Investor cooperation, and then in response to a period of social rupture caused by reduced investments. Adolescents were motivated by inequity aversion during normative Investor cooperation, whereas adults over-compensated the Investor. Participants were also identified as coaxers or non-coaxers based on how they responded to social rupture: 'coaxers' were individuals who made at least one relatively generous return to the Investor during this phase. A single coaxing move predicted consistently higher returns to Investors across both normative and reduced investments. Adults showed greater polarisation between coaxing and non-coaxing strategies than did adolescents. These data suggest that adults and adolescents may respond differently to periods of possible social rupture.

Key words: Social reciprocity, economic games; interpersonal; peers

Introduction

The social world becomes increasingly complex from adolescence to adulthood. Adolescents spend increasing amounts of time with peers compared with during childhood, while adulthood brings participation in hierarchical social organisations in the workplace and wider society (Antonucci & Akiyama, 1987; Henderson, 1977). Changes in the number of social contacts parallel qualitative differences in reactions to social situations across adolescence and adulthood (Blakemore, 2008; Blakemore & Choudhury, 2006; Brown, 2004), as well as in understanding peer cues and intentions.

Establishing and maintaining reciprocity is an aspect of social understanding crucial to the emergence of positive social relationships (Fehr & Gächter, 2000; Gouldner, 1960; Wolff, 1950). Measuring normative patterns of how reciprocity emerges in adolescence helps identify deviating patterns that may represent early risk factors for later social difficulties and emotional problems. The current study uses an adapted experimental task, the Trust Game, to measure and compare adults' and adolescents' capacity to engage in reciprocity during social exchanges, and the use of strategic responses to re-establish reciprocity when it breaks down.

Elucidating social functioning among adolescents has largely relied on questionnaires and naturalistic observations of social behaviour. Such studies show that during adolescence reciprocal behaviours emerge and diversify (Kim, Conger, Lorenz, & Elder, 2001; Priel, Mitrany, & Shahar, 1998), and that patterns of reciprocity begin to co-vary with closeness in social relationships and susceptibility to social influence (Clark & Ayers, 1988; Vaquera & Kao, 2008). However, questionnaires have been criticised for lacking ecological validity, while observational methods tend to suffer from poor standardisation (Bauer & Gaskell, 2000). An alternative but complementary method for studying social behaviour that has been applied in adults is the use of tasks borrowed from Game Theory. These have long been used in economic literature to operationalise interactions between partners and groups (Von Neumann & Morgenstern, 1953).

Such tasks can be useful in psychological research because they allow controlled, quantitative measures of social functioning (Gummerum, Hanoch, & Keller, 2008). For example, recent studies have used Game Theory-influenced paradigms to identify developmental processes in reasoning about fairness and intentionality between late childhood and adolescence (Almås, Cappelen, Sørensen, & Tungodden, 2010; Güroğlu, van den Bos, & Crone, 2009; Sutter & Kocher, 2007). While concerns have been raised about the ecological validity of these economic games, results from previous game paradigms have been validated by findings from observation data (McClure et al., 2007; Qualter, Brown, Munn, & Rotenberg, 2010).

The Trust Game provides indices of trust, a prerequisite of reciprocity in social interactions (Berg, Dickhaut, & McCabe, 1995). In this game, 2 players assume different roles: one an investor, the other a trustee. At the beginning of each round of the iterated game, the Investor is given \$10. They can choose to 'invest' any proportion of this amount with their Trustee, keeping the remainder for themselves. For example, the investor may keep \$5, investing \$5 with the Trustee. The amount invested is trebled when it reaches the Trustee (becoming \$15 in the example), and the Trustee can apportion this new amount between themselves and the Investor howsoever they choose. Thus in the example, the Trustee may choose to keep \$10 of this amount, returning \$5 to the Investor.

If the game is iterated over a number of rounds, each party can maximise their gains by maintaining reciprocally high offers throughout the game. For the Investor, this would involve making reasonably large investments, which the Trustee reciprocates by apportioning proportionately large amounts in return. This interaction requires the establishment of trust between players; if a participant perceives their partner to be making unfair offers, they will be less likely to cooperate in future rounds (Delgado, Frank, & Phelps, 2004). The Trust Game thus contains two useful metrics: Investor offers likely reflect their ability to trust a co-player, and Trustee responses likely reflect their capacity to reciprocate. As the Investor, normative patterns of cooperation involve sending roughly half of the possible \$10 to the Trustee (Berg, et al., 1995; Croson & Buchan, 1999). Furthermore, older adolescents and those with more pro-social beliefs tend to make larger investments in their co-player, compared to younger adolescents, and those with less pro-social beliefs (van den Bos, van Dijk, Westenberg, Rombouts, & Crone, 2011; van den Bos, Westenberg, van Dijk, & Crone, 2010). These data may suggest greater trust in their co-player's reciprocation.

The Trustee role is associated with distinct patterns of reciprocity (Camerer, 2003; King-Casas et al., 2005), though this has been studied less extensively than Investor behaviour among adolescents. One study comparing Trustee behaviours across various age groups found that although all individuals (including adolescents) were motivated to ensure equity of outcomes between Investor and Trustee, adults often exceeded equity and even over-compensated the Investor (Sutter & Kocher, 2007). In this context, 'equity' refers to returns made by the Trustee to the Investor which resulted in an equitable outcome for both players at the end of the round. Thus, in 'exceeding equity', the Trustee's responses resulted in the Investor having a larger payoff than the Trustee on that round. Such moves may signal the Trustee's capacity to maintain reciprocity. However, since Trustee moves follow offers made by the Investor, experimental manipulations of Investor responses can also inform the Trustee's capacity to engage in repair behaviours following social rupture. Exemplifying this, King-Casas et al. (2008) used the Trust Game to investigate differences in social exchange between healthy controls and individuals with borderline personality disorder. Crucially, the authors examined Trustee responses when reciprocal exchanges broke down as a result of changes in Investor behaviour. Psychiatrically-healthy individuals responded by engaging in repair behaviours that were termed 'coaxing'. Here, 'coaxing' was defined as any move in which Trustee responses were equal to or exceeded 33.3% of the total amount received by Trustees, specifically when responding to low investments. Because the initial amount sent by the Investor is always tripled, 33.3% of the total amount received by Trustees reflects a full reimbursement to the Investor. Although these coaxing moves decrease Trustees' payoff for that round, coaxing represents a longer-term strategy to maximise payoff by engendering reciprocal generosity in later rounds of the game (Dufwenberg & Kirchsteiger, 2004; King-Casas, et al., 2008). These gestures are thought to signal contrition to the Investor and show that the Trustee is a trustworthy social partner. Used in this manner, the term 'coax' is also to some extent informed by the 'raise-the-stakes' strategy identified and used by Roberts and Sherratt (1998), and Majolo et al. (2006), describing a strategy whereby players attempt to escalate their co-players' investment. However, Roberts and Sherratt's use of 'raise-the-stakes' implies low opening returns on the part of the Trustee, which is not a requirement for the term 'coax' used by King-Casas et al. (2008).

The present study used the iterated Trust Game to investigate whether adults and adolescents would show distinct patterns of social reciprocity when playing as Trustees. All participants played against a pre-determined set of Investor responses that moved from normative cooperation (Investor sending ~50% of their allocated amount) to reduced investment. Given Sutter and Kocher (2007)'s identification of inequity aversion as a primary motivator for Trustee behaviour, we hypothesised that responses to normative Investor offers would reflect motivations towards equitable outcomes. Tentatively, but in line with Sutter and Kocher's developmental findings, we expected to observe a distinction between age groups, whereby adolescents' responses to normative Investor offers ensured equity, but adult responses over-compensated the co-player. Second, we assessed differences in Trustee repair responses during ruptures to normative social exchange, via a period of reduced investments. Given the hypothesized poorer social understanding of the maintenance of reciprocity in adolescence, we expected adolescents to engage in fewer repair behaviours, and predicted that fewer adolescents would be categorised as coaxers when playing as Trustee. We also explored more subtle age-group differences in the nature of coaxing, by comparing Trustee moves in adult coaxers and non-coaxers relative to adolescent coaxers and non-coaxers.

Method

Participants

Twenty-four adults (50% male) aged 19–35 years, were recruited via posters and e-mails through a university. Twenty-seven adolescents (48% male) aged 13–14 years, were recruited from a mainstream school. Characteristics of participants that remained in the study are presented in Table 1. The adult and adolescent groups did not differ in proportions of male:female participants.

		Adolescents ($n = 27$)	**Adults** ($n = 24$)
Age	Mean age (SD)	13.84 (0.37)	23.04 (3.54)
Gender	No. of males	13	12
	% Male	48.1%	50%
Coaxing	No. of coaxers	16	17
	% Coaxers	59.3%	70.8%
Belief in deception	Mean score (SD)	5.33 (2.30)	4.26 (1.94)

Table 1: Participant demographic, questionnaire and task-based information

Procedure

Participants were tested individually and led to believe that their co-player was an unknown peer in either an adjacent room (adults) or another school (adolescents), who they would be playing via wireless internet. Following the game, participants received a deception debriefing in two parts. First, participants were asked what they thought of their co-player and if they noticed anything about them. This prompt was followed by the explicit statement that they were playing against a computer program, and participants were asked outright if they had guessed this. If participants answered 'yes' to this question, they were excluded from analyses (2 adults were excluded for this reason). However, this approach is susceptible to demand characteristics: participants may answer that they believed the deception in order to please the experimenter, when they may have had some doubts about the veracity of the experimental setup over the course of the study. Accordingly, the second part of the deception debriefing asked participants to indicate if they had had feelings of doubt about the experimental narrative, assessed using a 7-point scale, labelled at the extremes: 1 = *never doubted that my opponent* was a computer and 7 = *never doubted that my opponent was a human*. There were no differences across adults and adolescents in terms of the degree to which they believed the deception (Table 1; $t(45) = 1.73, p = .091$).

After debriefing, participants were reimbursed for their time. At the study's onset, participants were informed that they would be reimbursed with vouchers valued between £2 and £5, and that the more money they earned in the game, the more they would be reimbursed. We avoided providing a (fictional) direct correspondence between money earned in the game and reimbursement as this may have led to continual monitoring of payoffs across trials. This further deception ensured that participants believed that their moves influenced their partner's behaviour, as such a sense of control is a central tenet of game theory (Jervis, 1988). Since the partner's moves were pre-programmed, all participants were reimbursed the maximum £5 value at the end of the study.

Trust Game

The Trust Game comprised 14 rounds. In instructions to participants, the two roles in the game were referred to as 'Investor' and 'Trustee', of note in light of potential of variations in such instructions to influence behaviour in the Trust Game (Camerer, 2003). Participants were told that they would be playing as either the Investor or the Trustee, and that the roles would be randomly allocated to themselves and their co-player by the computer when the game program was started. In actuality, all participants were informed that they would be playing as the Trustee. All participants played against the same pre-programmed set of 14 responses, and participants were not told after how many rounds the game would end. The latter was done to prevent backwards induction to a Nash equilibrium, as can be the case when participants know the end-point of a game (Zagare, 1984).

On each round, the computerised Investor allocated a proportion of an initial £10 sum to the Trustee, which was then trebled. Participants decided how much of this resulting sum they wished to return to the Investor, and how much they wished to keep for themselves. Each round terminated with the total amounts gained by both the Investor and Trustee displayed onscreen. A schematic of the game is included as Figure 1. Rounds were grouped into 3 phases, differing in the nature of Investor decisions. In Phase 1 (Rounds 1–5) the Investor sent £4–£6 of the £10 available, representing a baseline phase of normative cooperation. In Phase 2 (Rounds 6–11), investments

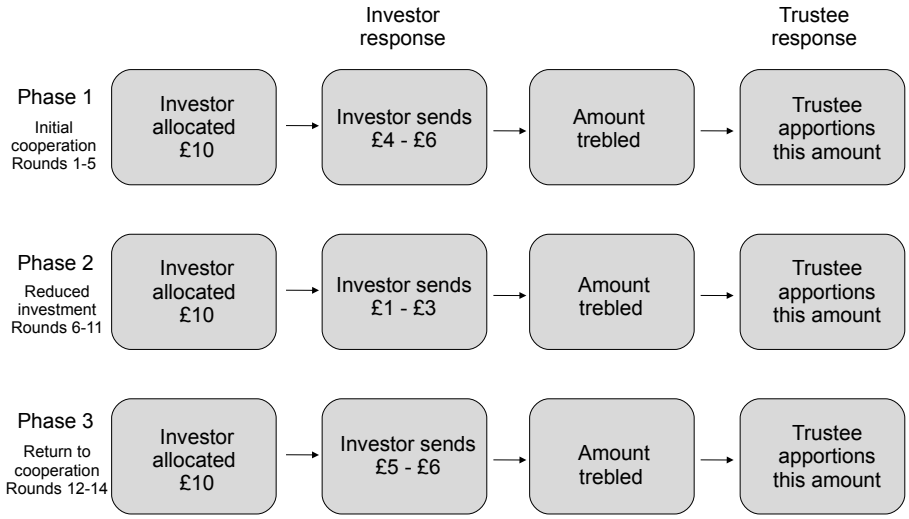

Figure 1: Trust Game schematic, showing the overview of an example trial from each phase.

decreased to £1–£3. Finally, in Phase 3 (Rounds 12–14) investments returned to baseline. Investor offers on each round are given in Table 2.

Investor behaviour during Phases 1 and 3 was informed by previous experiments indicating that normative investments are ∼50% of the initial amount available (Berg, et al., 1995; Croson & Buchan, 1999). Reduced investments (Phase 2) were based on King-Casas et al. (2008), which focused on investments perceived as low enough to elicit deviations from normative patterns of behaviour among participants. Such investments tended to be ∼20% of the total potential investment.

Coding Trust Game Responses

To compare behaviour across rounds where the Trustee received different investments, participants' responses were re-coded as proportions of the total amount that could have been returned to the Investor on each round. For instance, if the Investor sent £1 to the Trustee, then the participant would have £3 to allocate between themselves and the Investor; if the Investor sent £6, then the Trustee would have £18 to allocate. If the participant were to send back £3 in each case, the implications would be vastly different. In the example of an Investor decision of "Send £1" followed by a Trustee return of £3, the proportional return would be: $3/(£1 \times 3) = 1$ (100% of £3 was returned to the Investor). In the second example ("Send £6" followed by a Trustee return of £3), the proportion would be: $3/(£6 \times 3) = .167$ (16.7% of £18 was returned). In each example, the contextual difference of returning £3 is reflected in the discrepant proportional return scores.

Participants were classified as coaxers if they made at least one 'coaxing' move during Phase 2. We defined a coaxing response as one that occurred in response to a lower-than-normative Investor move, and in which repayment by the Trustee was equal to or exceeding a proportional score of .33. In the absence of any such moves, participants were classified as non-coaxers. The .33 proportion is used as this represents a full reimbursement of the Investor's initial outlay, given that this value is tripled before it reaches the Trustee. Our definition was informed by King-Casas et al. (2008), using the term 'coax' to refer specifically to moves made in response to lower-than-normative Investor moves, rather than to a more general usage of the term 'coax' to refer to increased returns to elicit greater subsequent investments. Of note, .33 is significantly higher than the mean proportional

		Adolescents		Adults		Equity
Phase 1	Round 1 (£5)		.35 (.02)		.53 (.03)	**.33**
	Round 2 (£4)		.32 (.03)		.42 (.03)	**.25**
	Round 3 (£5)		.32 (.03)		.40 (.03)	**.33**
	Round 4 (£6)		.31 (.03)		.44 (.03)	**.39**
	Round 5 (£4)		.33 (.04)		.35 (.03)	**.25**
		Non-coaxers	**Coaxers**	**Non-coaxers**	**Coaxers**	
Phase 2	Round 6 (£3)	.18 (.03)	.28 (.06)	.06 (.02)	.24 (.05)	**.11**
	Round 7 (£2)	.12 (.04)	.31 (.07)	.02 (.02)	.41 (.08)	**NA**
	Round 8 (£3)	.14 (.02)	.32 (.07)	.10 (.02)	.31 (.05)	**.11**
	Round 9 (£1)	.15 (.05)	.33 (.08)	.00 (.12)	.55 (.10)	**NA**
	Round 10 (£3)	.14 (.03)	.33 (.06)	.14 (.04)	.41 (.07)	**.11**
	Round 11 (£2)	.16 (.04)	.41 (.07)	.02 (.02)	.39 (.07)	**NA**
Phase 3	Round 12 (£5)		.36 (.04)		.37 (.03)	**.33**
	Round 13 (£6)		.33 (.04)		.42 (.03)	**.39**
	Round 14 (£5)		.32 (.03)		.35 (.02)	**.33**

Table 2: Mean proportional returns made by each age-group over Phases 1–3. Note: the bracketed monetary amounts in the second column of the table denote the investment made by the investor in the trustee on each round. Bracketed values in the main body of the table denote standard errors of the mean proportional returns. Bolded items in the ?nal column ('Equity') denote the proportion to be sent by the participant in order to ensure an equitable outcome for both players for that round. Adult and adolescent group means are given for Phases 1 and 3; these are further divided into adult and adolescent coaxers and non-coaxers within Phase 2.

returns during Phase 2: $t(50) = 2.61, p = .012, d = 0.74$. The mean number of coaxing responses made during Phase 2 by participants in the 'coax' group was 2.42 ($sd = 1.28$). Non-coaxers, by definition, made no coaxing responses.

Analyses

The study aimed to examine age effects on reciprocity in social exchanges during normative cooperation (Phase 1), and after rupture (Phase 2). In Phase 1 analyses, round was used as a single within-subject factor (Rounds 1–5) with age-group (adults, adolescents) as a between-subjects factor. The outcome measure was the proportional return made by participants on each round. Responses on each round during normative cooperation were also compared to responses that would have ensured equity of outcome for the Investor and Trustee using one sample t-tests. For instance, an equitable return on Round 1 (where the Investor sent £5) would be a proportional response of 0.33, resulting in £10 for both players. Responses exceeding this amount would over-compensate the Investor relative to the self, and vice-versa for responses lower than such returns. Age-group differences in reciprocity were examined separately during Phase 3 (return to normative cooperation). Again, a 2 (adolescents, adults) ×3 (Rounds 12–14) mixed-methods ANOVA was conducted. Phase 3 responses were also examined with regards to whether they would ensure equity of outcome for Investor and Trustee.

Trustee coaxing in response to low investment (Phase 2) was used to examine age-group differences in social behaviours after an Investor-led rupture to reciprocity. Within this second set of analyses, we first explored the number of coaxers versus non-coaxers in adult versus adolescent age groups using chi-square statistics. Second, we assessed whether age-group moderated the use of coaxing on proportionate return made by participants on each round, using a repeated-measures ANOVA with round as a single within-subjects factor (Rounds 6–11), and coaxing (coaxer, non-coaxer) and age-group (adults, adolescents) as between-subjects factors. Responses were not compared to moves that would ensure equity during Phase 2, as investments during this phase were low enough to render this impossible on a majority of rounds in the Phase (Table 2). As gender did not emerge as a significant between-subject factor in any analysis, reported analyses do not include this as an additional

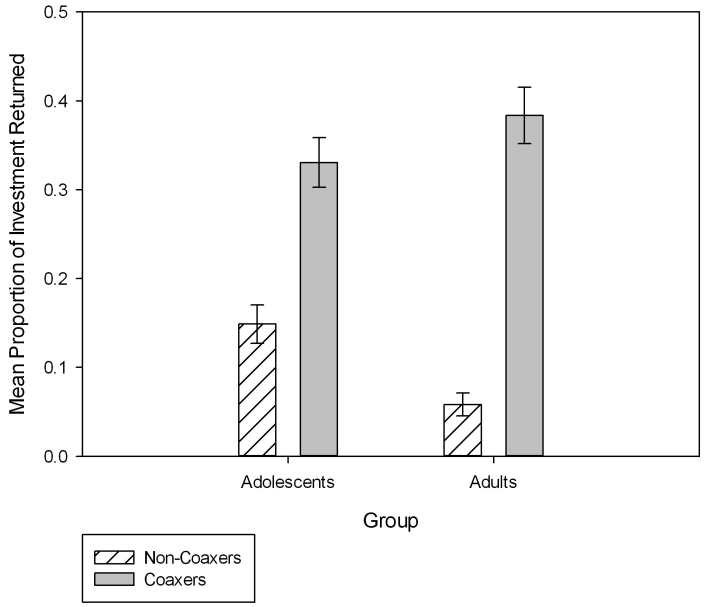

Figure 2: Proportional returns made by participants to co-player during Phase 1. Error bars $+/-1\sigma$

factor. Initial analyses also included participants' belief in the study's deception as a covariate. These scores were taken from the second part of the deception debriefing, which asked participants to indicate if they had had feelings of doubt about the experimental narrative. As controlling for belief did not affect the general pattern of findings, analyses are reported without the additional statistical control for deception. Analyses were originally conducted with a continuous measure of age as a covariate, but the reported analyses dropped this covariate due to its non-significance over and above the group-wise divisions in age.

Results

Age-Group Differences During Normative Social Cooperation (Phases 1 and 3)

A significant main effect of round was found during Phase 1 ($F(4, 196) = 4.47, p = 0.002, \eta_p^2 = .084$), specifically that proportional returns were lower in subsequent rounds than in Round 1 (Table 2). Inspecting within-subject contrasts over Phase 1 demonstrated a significant linear ($F(1, 49) = 12.76, p = 0.001, \eta_p^2 = .207$) pattern of decrease across the round. The effect of round was further modified by a Round-by-Age-Group interaction ($F(4, 196) = 2.84, p = 0.026, \eta_p^2 = .055$). This interaction, illustrated in Figure 2, shows the finding of decreased proportional returns across Phase 1 was driven by the adult group ($F(4, 92) = 6.59, p < .001, \eta_p^2 = .223$). Analysed independently, the adult group retained a significant linear decrease across the phase: $F(1, 49) = 15.79, p = 0.001, \eta_p^2 = .407$. Adolescent proportional returns remained constant across the phase ($F(4, 104) = 0.46, p = .765, \eta_p^2 = .017$).

Next, we conducted a series of one-sample t-tests to compare moves made by the adult and adolescent groups to proportional responses that would ensure equitable outcomes for the Investor and Trustee on each round of Phase 1. Comparisons of mean adult and adolescent responses to equity are shown in Table 2. Adults made returns significantly higher than what would be required to

ensure equity on all rounds during Phase 1, except Round 4 ($t_{Round1}(23) = 6.55, p < .001, d = 2.73$; $t_{Round2}(23) = 3.63, p = .001, d = 1.51$; $t_{Round3}(23) = 2.29, p = .031, d = 0.96$; $t_{Round5}(23) = 3.14, p = .005, d = 1.31$). In contrast, adolescents only made responses significantly greater than what would ensure equity on Round 2 ($t(26) = 2.48, p = .020, d = 0.97$) and Round 5 ($t(26) = 2.32, p = .028, d = 0.91$). No group effects of age-group or round characterised Trustee moves during Phase 3. Neither adults nor adolescents differed significantly from responses yielding equity of outcomes for Investor and Trustee on any round during Phase 3,

Age-Group Differences in Coaxing Responses to Reduced Investment (Phase 2)

There were no differences between adults and adolescents in the overall number of coaxers versus non-coaxers ($\chi^2(1) = 0.745, p = .285$, see Table 1). The mean number of coaxing responses made during Phase 2 by participants in the 'Coax' group was 2.42 ($sd. = 1.28$). Non-coaxers, by definition, made no coaxing responses during Phase 2.

However when the effects of coaxing group and age-group were used to assess proportionate returns across rounds of Phase 2, a significant coaxing*age-group interaction emerged ($F(1, 47) = 5.24, p = .027, \eta_p^2 = .10$). There was also a main effect of coaxing ($F(1, 47) = 65.36, p < .001, \eta_p^2 = .58$) but no main effect of Round ($F(5, 235) = 0.62, p = .682$) or Age-group ($(1, 47) = 0.36, p = .554$). The main effect of coaxing was due to consistently higher proportional responses across the period of reduced investment among individuals who made at least one coaxing move ($\bar{x}_{coaxers} = 0.36, sd = 0.02$) than those that did not ($\bar{x}_{non-coaxers} = 0.11, sd = 0.02$). This effect was moderated by age-group. To decompose the interaction between coaxing group and age-group, we examined proportionate responses collapsed across round in adult and adolescent coaxers and non-coaxers (Figure 3). Bonferroni post-hoc tests demonstrated that adult coaxers and non-coaxers were more dissimilar than any other pairing of groups, and showed a greater difference from one another ($t(20.24) = 9.50, p < .001$; mean difference= $0.33, d = 4.22$) than adolescent coaxers versus non-coaxers ($t(25) = 4.74, p < .001$; mean difference= $0.18, d = 1.89$) across all rounds. Mean proportional responses made by each group are given in Table 2, broken down by round across the phase.

We also re-visited data from Phase 1, including coaxing group as an additional between-subjects factor. While the main effects and interactions identified in the previous Phase 1 ANOVA remained, this analysis also revealed a significant main effect of coaxing group on magnitude of responses during Phase 1 ($F(1, 47) = 9.26, p = .004$). Those who coaxed in Phase 2 were already more likely to give higher returns during Phase 1. There were no additional significant interactions of either age-group or Round with coaxing group.

Discussion

The present study used a game-theoretic experimental paradigm to assess age-group differences in social reciprocity. Use of a game-theoretic paradigm allows for a controlled, quantitative account of social interactions, though potentially at the expense of ecological validity. We were interested in comparing reciprocity across adolescents and adults in response to normative co-player cooperation, as well as repair responses to social rupture. This work extends previous research which has used the Trust Game to assess Investor behaviour in adolescent samples. It replicates previous examinations of Trustee behaviour in adolescents, and extends to exchanges outside of normative cooperation. While Investor behaviour can inform instigation of cooperative or uncooperative moves, measuring Trustee behaviour reflects responses to such moves. Two key age-related findings emerged in our data. Firstly, adults approached the Trust Game with more generous returns to an unknown social partner than did adolescents. In particular, adults returned amounts that over-compensated the Investor. In contrast, while adolescents were motivated to ensure equity of outcomes for the Investor and Trustee, they rarely exceeded equity. These data replicate the findings of the pen-and-paper, gendered interactions described by Sutter and Kocher (2007) within an anonymous, gender-neutral,

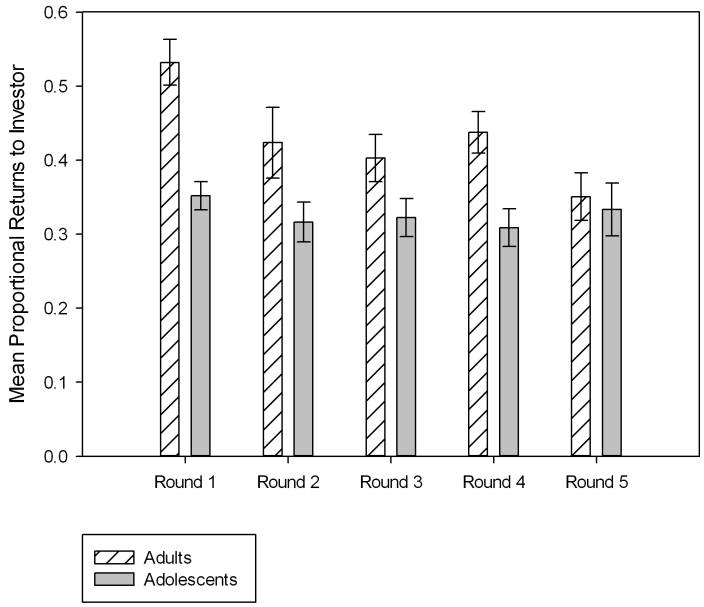

Figure 3: Mean proportion responses of adult and adolescent coaxers and non-coaxers across entirety of Phase 2. Error bars $+/-1\sigma$

computer-mediated paradigm. Given the sensitivity of responses in the Trust Game to situational effects (Camerer, 2003), this suggests the observed findings represent robust Trustee behaviours in adolescents and adults.

Adults and adolescents did not differ in the overall prevalence of coaxing behaviours as originally hypothesised; what varied was how coaxing moves were used as part of overarching strategies in re-instigating reciprocal relationships. The interaction between coaxing group and age-group suggested a greater polarisation of strategies between coaxers and non-coaxers in adults, but not adolescents. In adults, a single coaxing move predicted more generous responses across this phase, as well as during Phase 1. Adults who never coaxed showed the inverse, with consistently lower responses during the period of social rupture and during Phase 1. In adolescent coaxers, the use of these repair behaviours was less polarised, relative to non-coaxers.

These findings offer insights into age differences in reciprocity, establishing provisional yet distinct norms for adults and adolescents in patterns of reaction to social exchange and rupture. However there are several limitations. Although we build on previous work that measured social behaviours in economic games across development (Gummerum, et al., 2008), our sample size is relatively modest. However as few studies have used experimental designs such as the Trust Game to investigate age-group differences, the purpose of this study was to lay the foundation for future studies. Adults varied between 19 and 35 years, and it is possible that social functioning continues to change across this age range. However, previous data suggest little developmental variation in trust-related behaviour beyond early adulthood (Sutter & Kocher, 2007). Conversely, the adolescent group comprised individuals from the narrow age band of 13–14 years. As such it is unlikely that the group fully describes behavioural responses to social rupture across the entire period of adolescence. Future research could build on the presented gross-level differences by sampling from a larger set of developmental groups. For instance, a cross-sectional analysis including groups of 13–14 year olds, 15–16 year olds, 16–18 year-olds and so on, would speak more directly to gradual developmental changes between adolescence and adulthood. Though Sutter and Kocher (2007) used various developmental

groups in their analyses, we argue that adolescence is a key period of transition in these observed social behaviours, so a fruitful research area would examine development *within* adolescence rather than between adolescence and childhood.

Another caveat in interpretation of these data is that the discrepancy in generosity between the two age groups could be due to different valuations of the potential reimbursement: adult participants may not have considered 5 to be a particularly large amount of money, and so would have been less concerned about keeping as much as possible. This could be verified by replicating the current study and varying reimbursement (e.g. £1–£15) between participants. The current study provides some evidence that monetary amounts would not affect responses qualitatively, in that adults' returns declined over the course of Phase 1. This would not be expected if they didn't value the full amount of their potential reimbursement. However, it is possible that the mean difference in response amounts between the two groups could be affected by the size of reimbursement (Fudenberg & Tirole, 1991; Hoffman, McCabe, & Smith, 1996).

Findings are also limited in their generalisation to real-world settings. Use of the Trust Game as an index of reciprocity and reactions to rupture on the part of a social partner might not be said to capture the qualitative features of day-to-day interactions with peers. There is an implicit assumption in our approach that observed differences are specifically social, and that the Trust Game is a representative social paradigm. However, it may be the case that the relative polarisation of adults' responses to adversity is a domain-general finding that is not limited to social rupture. Clarifying whether this developmental difference is general or specific to social situations stands to better inform progression from the current findings to wider questions about sociality across development. Group differences could be due to cognitive abilities (e.g. ability to plan ahead) or socio-economic factors which are not specifically interpersonal in nature. Unfortunately the present study did not include socioeconomic measures or individual indices of cognitive abilities and so cannot test these claims. However, the reported group-level differences may serve as the basis for more stringent examinations of individual indifferences in successive work.

These limitations notwithstanding, our data provide preliminary suggestions of age-group differences in reciprocity, in particular to social rupture. A number of explanations may be proffered for developmental distinctions in coaxing. Firstly, variations in Investor behaviour may have been more salient to adults than adolescents. That is to say, changes between normative cooperation (Phase 1) and reduced investment (Phase 2) may have been interpreted as a meaningful change by adults, relative to adolescents. This would then have manifested in the more extreme strategies observed in response to the reduced investment among adults. Another possibility is that the adolescents were just as sensitive as the adults to the implicit rupture cues in Investor behaviour, but did not show equivalent adjustment of their responses. Such behavioural inaction could have been due to less effective strategies of social response in comparison to adults, or due to self-censoring biases in adolescents' responding (Ford, 1982). For instance, the adolescents may have noted the change in their partners' behaviour, but chosen not to greatly adjust their returns due to uncertainty about their own interpretations or social environments in general.

Conventional wisdom might interpret Phase 2 findings as development from general use of coaxing moves in adolescence to a more robust, reactive coaxing strategy in adulthood. However, both groups were led to believe that they would be playing against peers in the game. This means the groups differed not only in participants' age, but also in the age of their presumed co-player. Interacting with adolescents may be an extremely different social environment to interacting with adults (Brown, 2004), and each group may additionally show differential proficiency at interacting with one group versus the other (Blakemore, 2008). This is to say that profiles of responding to Investor non-cooperation seen in the present study could be dictated more by the social environment (presumed adult/adolescent co-player) than the individual's ability to recognise social cues and formulate appropriate response strategies. Repeating the experiment including crossed adult-adolescent design (i.e. participants being told that they are playing against either a peer or a member of the other age-group) would help clarify the nature of these potential effects. An alternative approach would be to give participants no information about their hypothetical co-player, which could control for dynamic effects of having a co-player outside of the participants' own peer group (e.g. qualitative difference between adolescents playing against presumed adolescents and adults playing against presumed ado-

lescents). However this approach would not be able to control for spontaneous assumptions by the participant about their co-player. For instance, it may be the case that both adults and adolescents, when given no information about their co-player, implicitly assume them to be from their own peer group, and play accordingly. In this case, perhaps future research would stand to be well-informed by both potential developments to the task. Furthermore it bears mentioning that, since adults were told that their co-player was in an adjacent room while adolescents were told that their co-player was in another school, there are potential group differences in perceived co-player proximity (Camerer, 2003). As such, future work looking to resolve ambiguities in the source of differences between adult and adolescent groups may wish to explicitly test effects of perceived proximity to co-player.

In conclusion, use of the Trust Game affords an experimental index of reciprocal social behaviour. Results allow for clarification of the actions that adults and adolescents will take in a social scenario where they are motivated to establish reciprocity and redefine an undesirable relationship. We reported a developmental difference closely related to the use of repair strategies among individuals experiencing the rupture of a social interaction. While these capacities appeared well-consolidated in adults, they were less robustly used in adolescents. Our findings give some idea of group level differences in response to our relatively blunt, but more importantly, standardised indices of social interaction and reciprocity. Developments of the current paradigm should next look at reactivity and dynamic social interaction beyond these.

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